

MODELING, SIMULATION, AND ANALYSIS FOR STATE AND LOCAL EMERGENCY PLANNING AND RESPONSE

MISSION NEEDS STATEMENT

REPORT DHS82T1

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Contents

INTRODUCTION	1
Purpose	2
Study Approach	3
Organization of This Report	4
IMPACT ON DHS MISSION AREAS.....	5
NEEDED CAPABILITY	6
Who Are the Users of the Capability?	6
What Are the Needed Capabilities or Functions	8
CURRENT AND PLANNED CAPABILITY	10
CAPABILITY SHORTFALL	11
IMPACT OF NOT APPROVING THE MISSION NEED	12
BENEFITS.....	12
TIME FRAME.....	13
CRITICALITY	14
LONG-RANGE RESOURCE PLANNING ESTIMATE	14

Mission Needs Statement

INTRODUCTION

Responding to catastrophic events, man-made or natural, places tremendous demands on governmental organizations at all levels. To respond as efficiently and effectively as possible, these organizations must determine the events, or threats, that are most likely to occur in their area of responsibility, prioritize the threats based on their predicted impact, and determine how to best apply their resources to mitigate, and prepare for, the threats. Not only must they assess the impact of these threats on their immediate area of responsibility, they must also make determinations on what if any collateral support will be required to support mutual aid or support agreements required by other jurisdictions, both within their area of responsibility and outside their jurisdictions. Because each threat's impact can vary depending on any number of conditions, multiple scenarios must be considered for each threat.

At-a-Glance
DHS/S&T is working to provide an integrated suite of modeling tools to state and local emergency planners and responders. The ability to use such tools varies greatly among the various local jurisdictions and tribal governments. The challenge is to produce tools that can be used by both well-funded jurisdictions and those with less funding and little or no IT support.

The Department of Homeland Security (DHS) has defined 15 National Planning Scenarios (NPSs), along with a Target Capabilities List, which describes needed capabilities related to the four homeland security mission areas: prevent, protect, respond, and recover. In addition, state and local emergency personnel must have plans in place for managing emergencies in their areas of responsibility.

In this mission needs statement (MNS), as well as in two companion documents (an operational requirements document and a concept of operations), we use the terms *emergency management* (EM) and *emergency services* (ES). We define those terms as follows:

- ◆ Emergency management—organizations charged with the managerial function of creating the framework within which communities reduce vulnerability to hazards and cope with disasters.¹ The emergency management community includes local, regional, tribal, and national agencies charged with maintaining the programmatic framework, managing program requirements, and administering local and federal funding.
- ◆ Emergency services—organizations that provide for public safety by the delivery of services such as law enforcement, firefighting, emergency

¹ FEMA's independent study course IS230, Principles of Emergency Management.

medical, search and rescue, and the like. The emergency services community includes all the emergency services providers/responders, including EM agencies.

Emergency management is often described as having a life cycle with specific phases. The three most commonly recognized phases are preparation, response, and recovery. Other categorizations exist; for example, the Federal Emergency Management Agency (FEMA) website mentions prevention, mitigation, and risk reduction, but these activities can take place as part of preparation and are not phases, per se.

To support the preparation and response phases at the state, local, and tribal levels, DHS's Directorate for Science and Technology (DHS/S&T) would like to develop a suite of models and other tools that state, local, and tribal planners can use for modeling, simulation, and analysis of likely threat scenarios. DHS/S&T's focus is on enabling its customers, the DHS components, and the components' customers—including federal, state, and local emergency responders—to achieve their vital mission of securing the nation. DHS/S&T also emphasizes that the implementation of such technology must focus on its use as a support “tool” that can augment, but does not in any way replace, essential human decision making.

DHS/S&T tasked LMI with conducting a gap analysis to identify the models and other tools needed by a broad spectrum of ES stakeholders for preparation and response and, considering the results of the gap analysis, with developing a mission needs statement, an operational requirements document, and a concept of operations. This report is the MNS.

Purpose

The MNS is a document that is a non-system-specific statement containing operational capability needs and written in broad operational terms. It describes required operational capabilities and constraints identified and studied during the concept development phase. The purpose of this MNS is to provide the foundation for the development of a suite of modeling, simulation, and analysis tools. It states generally what the ES community needs and the constraints under which the tools must operate. The MNS identifies the need for modeling, simulation, and analysis and for tools that enable those activities, such as

- ◆ tools to locate or collect data needed to run models;
- ◆ tools or systems that capture and prepare the data; and
- ◆ tools or processes that support the acquisition, maintenance, and training for modeling and simulation software.

Study Approach

This task called for interviewing stakeholders to gather information about the types of software they need to prepare for and respond to a threat. Our first steps were to draft interview guides (one for state-level emergency management agencies, or EMAs, and one for local jurisdictions) and construct a sample of stakeholders who adequately represent the ES community. We strove to include as many types of local jurisdictions as possible, to correct a perceived bias in prior studies toward larger jurisdictions. A team was assembled that included experts in emergency management, information technology (IT), and project and program management, as well as individuals who are experts in eliciting and analyzing software requirements.

The team interviewed state emergency managers individually and conducted group interviews with local jurisdictions to include as many disciplines (emergency management, fire, law enforcement, public works, medical, transportation, etc.) as possible. In addition, the team interviewed non-governmental organizations (NGOs) to understand their needs and their relationships with and dependencies on their government counterparts. We wanted to consider the role of NGOs because they are an integral and important part of many communities across the nation. In other words, we wanted to understand how local jurisdictions can work with their community counterparts and how shared models and tools might be utilized in the field. A total of 90 individuals participated in the interviews. Table 1 summarizes the demographics of the interview participants.

Table 1. Demographics of the Interview Participants

Population	Jurisdictions	EMA	Fire	Police	Public works	Medical	Elected	Other	Total
1–14,999	1 county, 1 city, 1 tribe	3				2			5
15,000–49,999	2 counties	2	1	1		1			5
50,000–99,999	2 counties	3	1						4
100,000–249,999	7 cities, 2 counties, 1 tribal consortium	9	10	2	2	3	1		27
250,000–499,999	3 cities, 4 counties	7	1	1		2			11
500,000–999,999	4 cities	4	2	2	1	3		1	13
1,000,000–4,999,999	1 county, 1 NGO	1				1		1	3
Over 5,000,000	1 city, 1 NGO	1				1		1	3
States	10 states	14					1		15
Pretest	State	4							
Total		44	15	6	3	13	2	3	90

The team completed a total of 48 individual and group interviews between March and August 2008; 14 of these were with state-level employees, and 32 were with local jurisdictions (two jurisdictions required a second interview). These jurisdictions were of various sizes and types (rural, city, county, tribal, and large urban areas) and in a variety of geographic locales (island, mountainous, coastal, and plains areas). All interview participants contributed voluntarily, and all information was obtained based on the understanding that it was not for attribution.

The team used a consistent process for all interviews. First, letters were sent to those in our sample to let them know of the study. Then, we discussed the interview concepts and process with four individuals at the state level, refined the interview guides, and began scheduling interviews. In advance of each interview (whether state or local), the team sent participants the interview guide and a description of the purpose of the study and areas of interest. At the local level, the interviews included questions on local hazards; planning, training, and exercising; response operations; recovery; daily use of computer tools; funding; and any other topic the interviewees wanted to discuss. Interviews were conducted by teleconference; interviewees were offered a copy of the notes taken, if they so wished. In addition, we collected information from the interviewees about the software and other tools that they use.

The team analyzed the interview notes and the information on software and other tools used by the interview participants to develop this MNS.

Organization of This Report

The remainder of this report addresses the following topics:

- ◆ Impact on DHS mission areas
- ◆ Needed capability
- ◆ Current and planned capability
- ◆ Capability shortfall
- ◆ Impact of not approving the mission need
- ◆ Benefits
- ◆ Time frame
- ◆ Criticality
- ◆ Long-range resource planning estimate.

IMPACT ON DHS MISSION AREAS

S&T's main focus is to enable its customers, the DHS component agencies and their customers, by

- ◆ creating a customer-focused, output-oriented, full-service science management organization that is consistent with its enabling legislation;
- ◆ incorporating lessons learned since the start-up of DHS to sharpen its focus on executing mission-oriented programs; and
- ◆ providing leadership and resources to develop the intellectual basis that is essential to mission success.²

DHS is one of the lead federal agencies in the national effort to secure America, prevent attacks, and protect against and respond to threats and hazards to the nation. State, local, and tribal organizations provide initial response activities in their own areas of responsibility. These state, local, and tribal organizations, knowing what response activities are required for their own local response, generate a tremendous amount of the available information on threats, hazards, preventive measures, and preparedness. DHS plans to provide a suite of tools that will enable better planning and response to a wide range of hazards that can be tailored to meet specific requirements at the state, local, and tribal levels. This information, as it aggregates from the state, local, and tribal levels and provides a clearer picture of response activities, in turn, can support better assessment of nationwide levels of preparedness.

Without more consistent use of tools to support state, local, and tribal planning, the ability to assess the level of preparedness for all hazards, including those in the NPSs, is limited. Considering the range of analytical expertise and resources available in different communities, the suite of tools must be developed with careful attention paid to the appropriate balance among level of sophistication, amount of detail, transparency, interoperability, cost, and ease of use. In addition, because the tools will be applied to a wide variety of situations, the suite should be robust, accommodate a broad range of scenarios, and accept data inputs at all levels.

The tools required by state, local, and tribal organizations to plan for emergencies must do the following:

- ◆ Identify hazards, predict hazard impacts, including casualty estimates, damage to infrastructure, impact on utilities and other key assets, and debris generation
- ◆ Predict the assets needed for response and for various hazard scenarios that threaten human population, physical property, or the environment

² From http://www.dhs.gov/xabout/structure/editorial_0530.shtm.

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- ◆ Generate information to support the operational plans.

The use of the proposed suite of automated and manual tools, along with the necessary data, will allow for coordinated planning and operations across various jurisdictions. A well-thought-out plan—with requirements based on sound methods, using the best tools available, determined prior to any event, and visible at all level of response—will guide the efforts and activities of all responders. DHS will then have a much clearer and more concise picture by which to formulate plans to address the 15 National Planning Scenarios.

NEEDED CAPABILITY

The deficiencies in DHS’s current ability to support an integrated suite of modeling, simulation, and analysis tools drive a set of mission needs for DHS. Although this project’s title indicates a focus on planning and response, multiple other perspectives also must be considered.

Who Are the Users of the Capability?

Users at the state, local, and tribal levels can be characterized according to their focus on a particular phase of emergency management, or by their discipline, or by their subject matter expertise. Any DHS effort to provide integrated modeling, simulation, and analysis tools must take into account all phases of emergency management, as identified on the DHS website:

- ◆ Preparedness (including planning, training, and exercising)
- ◆ Response
- ◆ Recovery
- ◆ Mitigation.

To characterize users according to their discipline or subject matter expertise, we use the Emergency Support Functions (ESFs):

1. Transportation
2. Communications
3. Public works and engineering
4. Firefighting
5. Emergency management
6. Mass care, emergency assistance, housing, and human services

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7. Logistics management and resource support
 8. Public health and medical services
 9. Search and rescue
 10. Oil and hazardous materials response
 11. Agriculture and natural resources
 12. Energy
 13. Public safety and security
 14. Long-term community recovery
 15. External affairs.

The functions inherent in emergency planning and response—and the users of the needed tools—span all the phases and all the ESFs, as evidenced by the following two examples:

- ◆ A fire chief needs a tool to estimate the number of ambulances that will be needed to respond to an incident. That same tool should be used during exercises, because as the scenario provides new inputs, requirements may change.
- ◆ An emergency manager at a county Emergency Operations Center needs a tool to identify and describe what resources are located where in the county. During an incident, that tool needs to track which resources have been assigned, and where. During recovery, the condition of those assets needs to be assessed and noted as they are returned to “inventory,” or if not returned to inventory, their status: in repair, disposal, etc.

Clearly, many combinations of emergency management phases and ESFs must be considered when planning and responding to emergencies.

Although this program focuses on the users at the state, local, and tribal levels, it could support some DHS-level functions as well. All data start as local assessment and planning data and *should* roll up into state-level information and data. In current practice, some jurisdictions use no software at all, while others use software for some functions but not others. Even in large cities, some planning functions are unsupported by software. Thus, the existence of good data is spotty; even when good data exist, in most cases, they cannot be aggregated without considerable human intervention.

If state, local, and tribal users use consistent processes, tools, and data to plan and respond, their data become more consistent. If DHS-level users would like to

aggregate data at the regional or other level to determine, for example, how prepared an area is for one of the National Planning Scenarios, DHS must provide standard processes, tools, and business rules so that data can be aggregated accurately.

What Are the Needed Capabilities or Functions?

Users at the state, local, and tribal levels need more than modeling tools. The technical environment for these users varies greatly, but it is rare that the emergency management function has strong IT support. In general, the users have little to no funding or support for the following:

- ◆ Analysis of software requirements
- ◆ Assessment of commercial off-the-shelf software
- ◆ Planning for an integrated software suite
- ◆ Deployment of software, including
 - customization,
 - installation,
 - rollout,
 - training, and
 - maintenance.

State, local, and tribal organizations have implemented software where they could. This has led to a community that utilizes a very “mixed bag” of tools. If DHS supports a common suite of tools, users can select a specific tool for implementation based on what they can support at that time and on what will be most beneficial, along with any tools they already have in place.

By supplying and supporting a suite of modeling and other tools, DHS can both enable users to select the tools needed for their particular focus (phase, ESF, or a combination) and, over time, ensure compatibility with tools supporting other functions and, more important, the data and outcomes that the tools produce.

The program to develop modeling, simulation, and analysis tools for state, local, and tribal emergency planning and response should start by leveraging existing resources into technological tools to help protect state, local, and tribal communities. This program supports efforts by state, local, and tribal governments with analytical processes to determine what is required for delivering the initial response to the range of disasters they may face.

The following are basic functions that these tools must support:

- ◆ Assess risk against the most likely scenarios
- ◆ Assess risk against various policy options
- ◆ Identify potential political influences
- ◆ Measure the scope of the potential event to determine the amount of planning needed
- ◆ Estimate the ability of existing infrastructure to absorb the changed population that will result from the disaster, both short and long term
- ◆ Identify the additional resources needed to achieved response and recovery goals
- ◆ Identify where resources should be located for the most effective and efficient response
- ◆ Show resource needs for the immediate response, as well as for the duration of the event and into the initial stages of recovery
- ◆ Establish standards for returning emergency service and response resources to a state of readiness for the next major event
- ◆ Cover a comprehensive range of hazards.

Users need assistance with determining what tools are needed, as well as with long-term planning for the acquisition, deployment, and maintenance of tools and with training.

The suite of tools needs to support a wide range of users and to operate in various environments with varying levels of resources. The proposed planning and response modeling, simulation, and analysis solutions should have the following characteristics:

- ◆ Be accessible to users through web access or as an optional standalone program
- ◆ Have easy-to-use graphical interfaces
- ◆ Use standardized data inputs
- ◆ Be customizable based on local data, conditions, and demographics
- ◆ Be independently usable by local practitioners
- ◆ Be transparent and understandable

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- ◆ Provide a decision support capability
 - ◆ Be scalable across a wide range of communities
 - ◆ Operate seamlessly during normal operations or for the duration of an event.

Because the tools must support construction of plans for a wide range of events and communities, flexibility and the ability to use standard data sources will be crucial design features. The tools must accommodate a diversity of event types, populations, and geographic areas.

CURRENT AND PLANNED CAPABILITY

Currently, no single repository provides users with standard practices or policies regarding software acquisition and deployment, nor do any groups (such as a special interest group or community of practice) focus on the general issue of such tools to support all facets of emergency management in a government environment. Many tools have been developed by federal, state, and local governments; by universities and commercial entities; and by individuals. However, users are left to discover the existence of tools by any means possible, for example, word of mouth at meetings with peers or during training for some other purpose, Internet searches, or contacts with vendors. In short, users have no central place where they can find out what software exists, what functions it performs or supports, how well a given software tool works, and whether compatibility and interoperability issues exist, as well as other factors that affect the suitability of software for a given situation.

Not only do users have no central place to obtain information about emergency planning and response tools, but their ability to investigate tools is constrained by tight budgets and continual changes in technology, threats, and personnel. In addition, because most jurisdictions do not have robust IT support, investigation of tools must be done by emergency management experts instead of by software experts.

Planned capability includes user support tools such as the following:

- ◆ Guides for acquiring software to support emergency management
 - Analysis of needs and the current environment
 - Prioritization of needs and analysis if there are tradeoffs
 - Assessment of available software against requirements
 - Enterprise licensing, consortia, and other options for licensing (both for acquisition and for maintenance)

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- Assessment of life-cycle costs of software support to emergency management
 - ◆ Web-accessible guides to available software (both modeling and other emergency management support)
 - Software descriptions
 - Links to providers (commercial or no-cost)
 - Downloadable applications in the public domain
 - ◆ Web support for users to discuss and collaborate on acquiring and supporting software for emergency management.

CAPABILITY SHORTFALL

Although many communities perform emergency planning and response functions today, the use of modeling, simulation, and analysis tools is limited due to the lack of visibility into available software and the inability to adequately compare available tools. More generally, available models are considered by state, local, and tribal planners to be inadequate because they are

- ◆ too complicated;
- ◆ standalone software—they do not integrate with other software in use;
- ◆ unable to account for local conditions;
- ◆ inaccessible to state, local, and tribal communities;
- ◆ too expensive to obtain, learn, and operate;
- ◆ unable to account for the full range of hazards; and
- ◆ unable to accommodate political influences that affect planned responses.

Many users have resource limitations, both in staff and in funding; they have difficulty finding tools that support their requirements. This capability deficit and the resulting planning shortfalls often lead to a fragmented, inadequately coordinated, and inefficient response when an event actually occurs. This lack of an integrated process also brings into question the viability of some of the planning factors used to develop response requirements.

IMPACT OF NOT APPROVING THE MISSION NEED

This MNS provides the foundation for deriving the concept of operations and the operational requirements document. Those documents will detail shortfalls and gaps, impacts, requirements, and projected schedule and costs. If the mission need is not approved, emergency planning and response will continue to be disjointed, disorganized, and fragmented, precluding a comprehensive and coordinated incident response.

The following are some examples of specific impacts:

- ◆ The ability of DHS to support state, local, and tribal responders as they develop and identify desired and required capabilities to plan effectively will be severely degraded.
- ◆ The National Planning Scenarios and their impacts on people and infrastructure cannot be analyzed.
- ◆ A well-thought-out plan, at all levels of government, based on available models with accurate data will be difficult to achieve.
- ◆ Without accurate and achievable operational plans and requirements at the state, local, and tribal levels, DHS will be unable to efficiently formulate any plans or estimate requirements.

BENEFITS

Examples of benefits that may be achieved from approving this MNS are as follows:

- ◆ Analytical tools with accepted methods and accurate databases will be available to planners, practitioners, and officials at all levels and across all functional areas (law enforcement, public health, medical, firefighters, and so on).
- ◆ Planners will be able to customize tools based on their particular situation and develop “what-if” scenarios. These scenarios could reflect actual requirements, exercise scenarios, or requirements for supporting other jurisdictions and other functional areas.
- ◆ Standardized planning factors that lead to accurate estimates of response requirements can be viewed and made available to supporting partners, which will enable them to aggregate and plan their support to cover a wider range of jurisdictional or geographical entities.

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- ◆ Stakeholders will have
 - clear guidance on how to conduct effective planning and analyses,
 - training on the use of the suite of tools,
 - a template for understanding what organizations will provide aid and when, and
 - a clearer understanding of operational roles and responsibilities.

TIME FRAME

This program will require a multiyear effort for a number of reasons:

- ◆ Users vary widely in their readiness and ability to adopt and maintain software; some users do not have the infrastructure (computers, networks) to support software.
- ◆ Defining the tools to be included in the integrated suite will take time; users must be involved to ensure that their priorities are met.
- ◆ Adoption of tools must proceed logically. Users cannot adopt all the needed tools at once; instead, they must gradually adopt the tools that make up the integrated suite.
- ◆ Design of the integrated suite of tools will have to accommodate a wide variety of user environments:
 - Those with installed commercial software and some public domain software
 - Those with no software
 - Those with only models in the public domain (ALPHA, for example).

At the end of the multiyear effort, most users will have adopted the tools that are most appropriate to satisfy their own and DHS's needs.

CRITICALITY

Improvements in the completeness and consistency of, and visibility into, emergency planning and preparedness across the nation are critical to DHS. They also will support or complement other DHS efforts to develop modeling, simulation, and analysis tools, as well as the daily operations of state, local, and tribal stakeholders:

- ◆ DHS uses modeling and simulation for multiple purposes, for example, for training and for estimating impacts of various hazards, which feeds planning. One office in DHS is developing a modeling and simulation framework with which planning and response tools for state, local, and tribal users must align. As that framework matures, this program should ensure compliance with architecture and other framework elements.
- ◆ Stakeholders state that software used for planning should also be used in response operations, and that software used in response operations must also be used in day-to-day operations. This implies that tools used to develop estimates and other plans must become part of the software suite used for daily operations.

LONG-RANGE RESOURCE PLANNING ESTIMATE

Over the next 4 years, software to support modeling and simulation will be developed and delivered to the ES community via one or more DHS websites. This will require resources from DHS/S&T, as well as some support from other DHS agencies and offices. This section estimates resources overall; it does not attempt to determine what portion of the resources will come from any particular DHS office or agency.

Assumptions are as follows:

- ◆ A web portal will be used to provide a single web resource that provides all the models, simulations, and support elements (training, guidance) needed.
- ◆ Users will not need any specialized software to use the models; they will need only a web browser.
- ◆ Sample users (planners and decision makers from large and small jurisdictions with different threats) will participate in the design. They will travel twice (at the expense of this project) to meet and refine requirements with the developer, and they will participate in web meetings for this purpose.

- ◆ The portal will be rolled out in phases. From the start, it will include models to support some of the NPSs, as well as models that were most commonly requested in the interviews.
- ◆ A resource management system (developed elsewhere in DHS) will catalog resources according to the resource typing guidance issued by the FEMA's National Integration Center Incident Management Systems Division.
- ◆ Users of the portal will use the asset management system to capture data about their resources. Those data, in turn, will become available for matching against the Target Capabilities List of resources for any one of the NPSs for which they plan.

Figure 1 is the project plan for designing, developing, and deploying the portal. The project plan includes two development iterations of the portal. It also includes two face-to-face meetings between a user group with about 10 non-local members and the developers, as well as several web meetings. It requires approximately the same level of funding as year 1 of this project. It shows an aggressive schedule. If getting buy-in from the user community takes longer than expected, or if funding is a constraint, the schedule may be extended and the cost spread over 2 years.

Figure 1. Project Plan

ID	Task Name	Duration	Start	Finish
0	DHS M&S PORTAL	256.5 days	Wed 10/22/08	Thu 10/15/09
1				
2	Form Users' Group for UICDS and Portal	25 days	Mon 11/3/08	Fri 12/5/08
8				
9	Develop Prototype / Mockup of Portal	78 days	Wed 10/22/08	Fri 2/6/09
10	Refine Requirements	58.5 days	Mon 11/3/08	Thu 1/22/09
15	Obtain Models for portal inclusion	30 days	Mon 11/3/08	Fri 12/12/08
19	Design / Develop portal screen mocku	65 days	Mon 11/3/08	Fri 1/30/09
27	Clean-up Development	5 days	Mon 2/2/09	Fri 2/6/09
29	Review of portal functionality and usability	51.5 days	Wed 10/22/08	Thu 1/1/09
34				
35	Design and Develop Portal: Round 2	105 days	Thu 1/1/09	Thu 5/28/09
40	Design one new model	85 days	Thu 1/1/09	Thu 4/30/09
43	Testing	10 days	Thu 4/30/09	Thu 5/14/09
46	Portal 2 Rollout	120 days	Thu 4/30/09	Thu 10/15/09

In the outyears, following the large-scale rollout (in year 2, or year 3, depending on constraints), the portal will have from 10 to 20 independent models (HAZUS, EMCAPS, FEMA Vulnerability Analysis, etc.). Once the set of models is

determined to be complete, the emphasis will shift to ensuring that what has been delivered is being used effectively. Depending on the users' priorities, this may mean the following:

- ◆ Focusing on training materials (for individual models, for planning processes, or for how best to use the portal)
- ◆ Focusing on integrating the models with one another (for example, integrating a particular threat model with an evacuation model)
- ◆ Focusing on integrating with other software such as asset management software and a human resource credentialing system (both of which may present a dependency on FEMA)
- ◆ Providing the ability to download and run models on the local area network, which will require the development and implementation of a data synchronization process.

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